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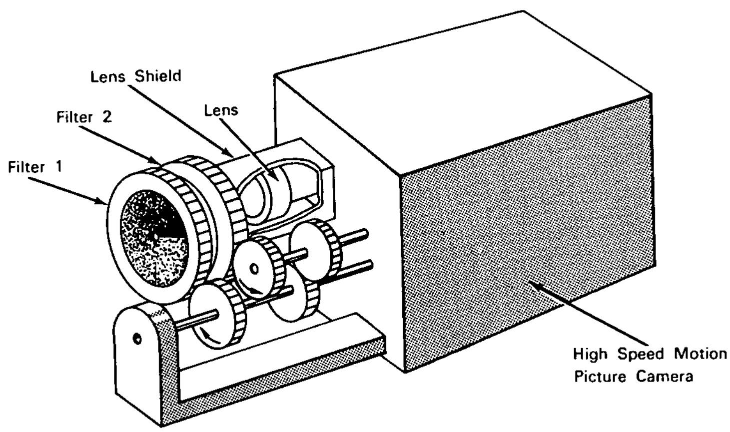
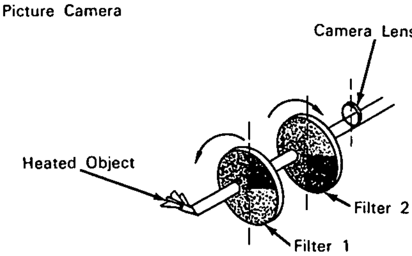
NASA TECH BRIEF

Rotating Filters Permit Wide Range of Optical Pyrometry





ALIGNMENT OF FILTER AND LENS

The problem: The present practice of photographic pyrometry is confined to a rather narrow range of temperatures per camera in use, due to the limited capability of current photographic emulsions to reproduce the brightness contrast of an object as it is heated. To determine surface temperatures of an object where the temperature variation is more than a few hundred degrees F, current practice is to use several lenses on a single camera, each with a different exposure setting. In an application involving temperature variation of several thousand degrees F, this technique becomes impractical because of the prohibitive number of lenses required.

The solution: A high-speed motion picture camera (single-lens system) with gear-driven dual filter disks interposed between the camera lens and the heated object. The filters are of graduated density to vary linearly with respect to rotation, thus affording, in conjunction with camera speed, the equivalent of many exposure settings.

How it's done: Each filter disk is linearly variable in optical density in a circular direction about the center, with radial ray from center to rim constant in density. An initial ray has a transmission density of zero and each succeeding ray around the disk a greater density according to a linear gradient until a

(continued overleaf)

terminal ray of maximum density, immediately adjacent to the initial ray, is reached. The two disks are identical but are so mounted that their density gradients are opposite in sign. In their starting position, the boundaries marking the abrupt transition from zero to maximum density of the two disks are aligned as shown above. The camera lens lies in a plane between the centers and rims of the filter disks which have conventional gear teeth on their rims and are driven in opposing rotation by the gear arrangement shown in the drawing. A lens shield protects against interference from extraneous light. These gears are driven by the camera film transport mechanism in such a relationship that one complete revolution of the filter disks takes place for each 18 frames of film exposed. Due to the range in exposure between the zero and maximum density portions of the disks passing before the lens, at least one of the 18 frames will be exposed properly and will be useful for surface temperature calculation.

Notes:

1. With the filter rotation to camera speed ratio outlined, a complete time-temperature history has been made over a range of 1800° to 4500° F.
2. The graduated-density filter disks used are commercially available.
3. This system of pyrometry can be used to record gray body temperatures over a very wide range with accuracies better than 2-1/2%, permits temperature gradient and time history measurements over extended surfaces, and is relatively insensitive to surface emissivity changes.
4. This technique should find application in the fields of metallurgy, crystal growing, glass research, plastics, and refractory research.
5. This innovation is further described in "Motion Picture Camera for Optical Pyrometry" by H. K. Strass, U. S. Patent No. 3,041,924 dated July 3, 1962. Inquiries may also be directed to:

   Technology Utilization Officer
   Langley Research Center
   Langley Station
   Hampton, Virginia, 23365
   Reference: B65-10100

Patent status: NASA encourages the commercial use of this invention. It has been patented by NASA (U.S. Patent No. 3,041,924), and royalty-free license rights will be granted for its commercial development. Inquiries about obtaining a license should be addressed to NASA, Code AGP, Washington, D.C., 20546.

Source: H. K. Strass, J. H. Siviter, Jr., and R. J. Exton
(Langley-33)